REMARKS

Claims 1, 2, and 21-24 are pending in the Subject Application. Claims 3-20 were withdrawn in response to the election made by telephone on July 26, 2005 and are cancelled herein. New claims 25-35 are added with this amendment.

Claims 1, 2, 23 and 24 have been amended. Basis for the amendments and for added claims 27 -35 can be found in Table 3 of the Specification at page 8. Basis for new claims 25 and 26 is in existing claims 21 and 22. No new matter is introduced by the amendments or the new claims. Applicants have filed herewith a Request for Continuing Examination, together with the required fee. Entry and consideration of the amendments, new claims and evidence submitted herewith are requested.

As a preliminary matter, the undersigned takes this opportunity to thank the Examiner for the courtesy extended during the interview of July 27, 2006. Applicants submit herewith the Declaration of John Paules, the subject matter of which was discussed at the interview.

Prior Grounds for Rejection

1. The Examiner maintained the prior grounds for rejection of claims 1, 2, 21 and 22. He rejected claim 1 under 35 U.S.C. §102 (a) as being anticipated by either of Hasegawa, U.S. Patent No. 5,766,376 or Ishii, U.S. Patent No. 6,494,970 on the same grounds as stated in the Office Action of August 2, 2005.

2. The Examiner rejected claim 2 under 35 U.S.C. §103(a) as being unpatentable over the Hasegawa patent in view of Table 1.1 of Introduction to Steels and Cast Irons for the same reasons as stated in the Office Action of August 2, 2005, wherein the Examiner had stated that the differences in Si content between the Hasegawa patent and claim 2 were a mere difference in the proportion of the element without any attendant unexpected results which would distinguish the claim over the prior art.

3. The Examiner rejected claims 21 under 35 U.S.C. §102 (a) as being anticipated by, or in the alternative, under 35 U.S.C. §103(a) as being obvious over the Ishii patent alone or in view

of Lyon, U.S. Patent No. 2,942,339 on the same grounds as stated in the Office Action of August 2, 2005.

4. The Examiner also repeated his rejection of claims 21 and 22 under 35 U.S.C. §103(a) as being unpatentable over the Hasegawa patent alone or in view of the Lyon patent.

New Grounds for Rejection

5. The Examiner rejected claim 1 under 35 U.S.C. §103(a) as being unpatentable over Lee, Korean Patent No. 9004845 (Abstract). The Examiner stated that Lee teaches an alloy steel having amounts of specified elements which overlap with the claimed ranges of claim 1 and that it would have been obvious for one skilled in the art to select the desired amounts of the elements from the ranges disclosed by Lee because Lee teaches the same utility.

6. The Examiner rejected claims 1 and 2 under 35 U.S.C. §103(a) as being unpatentable over Kenichi et al., Japanese patent publication 09-194998 because Kenichi teaches an alloy steel having amounts of specified elements which overlap with the claimed ranges of claims 1 and 2 and that it would have been obvious for one skilled in the art to select the desired amounts of the elements from the ranges disclosed by Kenichi because Kenichi teaches the same utility.

7. The Examiner also rejected claims 1 and 2 under 35 U.S.C. §103(a) as being unpatentable over Kenichi et al. in view of Table 1.1 of Introduction to Steels and Cast Irons.

8. The Examiner also rejected claims 21 and 22 under 35 U.S.C. §103(a) as being unpatentable over the combination of Kenichi and Lyon because Lyon teaches the use of low-carbon steel for a bomb casing.

9. The Examiner rejected claim 23 under 35 U.S.C. §103(a) as being unpatentable over Lee in view of Table 1.1 of Introduction to Steels and Cast Irons because Lee teaches an alloy steel having amounts of specified elements which overlap with the claimed ranges of claim 23 and that it would have been obvious for one skilled in the art to select the desired amounts of the elements from the ranges disclosed by Lee because Lee teaches the same utility and Table 1.1 teaches certain attributes of Silicon.

10. The Examiner rejected claims 23 and 24 under 35 U.S.C. §103(a) as being unpatentable over Kenichi in view of Table 1.1 of Introduction to Steels and Cast Irons because Kenichi teaches an alloy steel having amounts of specified elements which overlap with the claimed ranges of claims 1 and 2 and Table 1.1 teaches adding silicon to increase solid solution strength and hardness. The Examiner determined that it would have been obvious for one skilled in the art to add the desired amount of silicon as taught by Table 1.1.

11. The Examiner rejected claims 1, 23 and 24 under 35 U.S.C. §103(a) as being unpatentable over Kishida, U.S. Patent No. 4,729,872 because Kishida discloses and alloy steel composition which overlaps the claimed alloy and that it would have been obvious for one skilled in the art to select the desired amounts of the elements from the ranges disclosed by Kishida because Kishida teaches the same utility.

The Claims

Claims 1, 2, 23 and 24 have been amended to recite certain of the properties of the alloy. Claim 1 states that the alloy has, among other elements, an amount of silicon up to about 1.25% maximum and an ultimate tensile strength level of about 233-270 ksi. Claim 2 recites an alloy steel having an ultimate tensile strength level of about 233-270 ksi and Charpy V-notch impact strength of about 20-43 ft-lb at -40°F. Claim 23 recites an alloy steel having, among other elements, 0.28% carbon, about 1.00% silicon, about 1.03% nickel, about 1.17% tungsten and about 0.02% calcium, with a strength level of about 233-270 ksi. Claim 24 recites an alloy steel similar to that of claim 23 having in addition, a Charpy V-notch impact strength of about 20-43 ft-lb at -40°F. The amendments previously made to the transition phrase of claims 1 and 2 have been changed to "comprising". The transition term recited in claim 23 has been similarly changed.

New claims 25 and 26 are directed to bombs made of the material recited in claims 23 and 24, respectively. New claims 27 and 28 depend from claims 1 and 23, respectively, adding in each claim that the alloy steel has a Charpy V-notch impact strength of about 20-43 at -40°F. New claims 29 – 35, which depend from claims 2, 23, 2 and 1 add the ultimate tensile strength levels set forth for each example in Table 3.

As stated above, basis for the amendments and the new claims can be found in the values for the properties set forth in columns 8 and 13 of Table 3 of the Subject Application for the samples of the claimed steel tested. The ranges in claims 1, 2, 23 and 24, for example, are found in the ultimate tensile strength values set forth, including the identified standard deviations (hence, "about") for all five of the samples tested, ES-1 to ES-5, rounding to the nearest whole numbers. The ultimate tensile strength for claims 29-35 is found in the individual values for ES-1 to ES-5, rounding to the nearest whole number, including the identified standard deviations (hence, "about").

Differences between the Cited References and the Claimed Alloy

The Examiner has cited the Lyon patent, filed in 1955, for its reference to the use of low carbon rolled steel plate to make bomb casings. As the representative of the assignee of the Subject Application explained, bombs during that period were designed to attack surface targets. This old technology is still in use today for surface targets. Because many critical and sensitive enemy locations are designed and built, or hardened, to withstand possible attack, penetrator bombs were developed in about the 1980s to penetrate such hardened targets, survive the penetration to reach a predetermined depth and detonate at the desired location, thereby defeating threats which are impervious to the general purpose bombs. As explained on page 2 of the Subject Application, the materials heretofore used to make penetrator bombs, such as AF-1410, include costly elements, such as high amounts of Nickel, and are thus very expensive to produce. In addition, the process for making the high Nickel alloys takes several months.

The alloy steel claimed in the Subject Application is the result of collaboration between the U.S. Air Force and private industry to develop dual use technologies and specifically, to develop a material that would meet the requirements for high strength, high impact uses, such as use in materials for penetrator bombs, at a substantially lower cost and with a much faster manufacturing time. The steel alloy of the Subject Application can be produced in less than two weeks, as compared to months for conventional penetrator materials.

Applicants provide herewith the Declaration of John Paules. Mr. Paules has worked extensively with the steel alloy that is claimed in the Subject Application. As Mr. Paules states,

a distinction between the claimed alloy, referred to as Eglin Steel, and the steels described in the cited references is the modification of a relatively low-alloy NiCrMoV steel with relatively low carbon content via additions, in one of the disclosed embodiments, of about 1.0% Si and about 1.1% W, together with a special heat treatment to produces an ultra-high strength alloy steel with high toughness and a large degree of strain hardening. The unique combination of elements in the alloy in the amounts recited in the claims, when treated as described in the specification, provides properties ideal for high strength military and commercial applications. Those properties, specifically ultimate tensile strength and impact strength, are now recited in varying detail in the claims.

The Declaration includes as Exhibit I, a comparison between the Eglin Steel chemistry, as shown in the embodiments of Tables 2 and 3 and in claims 1 and 2 of the Subject Application, and that of the specific examples and ranges cited in references. Although the references include, in some cases, broad ranges, the amounts used in the specific examples differ significantly for many elements from the amounts claimed in the Subject Application. As Mr. Paules explained, although there is overlap in the ranges described, the actual compositions used in the examples of the references and, importantly, the manner of processing the substituents of the various alloys are quite different from the substituents recited in the claims and the properties of the claimed alloy.

The steel alloy, as recited in claims 2, 23 and 24 has about 1.0% Si. Claim 1 now provides that there is some amount of Si up to 1.25% and requires that the alloy have an ultimate tensile strength in a range of about 233-270 ksi, a property not possible with the alloys taught by the cited references, as explained below and in the Declaration. Although the Lee and Kenichi references show 1.0 % Si as the high end of their respective ranges and the Kishida references includes 1.0% within its range, this amount of Si in applicants' claimed alloy is much higher than that <u>actually used</u> in the examples of the steels of the cited references. This is important because applicants' elevated Si content allows low temperature tempering. The cited references do <u>not</u> describe the use of low temperature tempering to produce the disclosed alloys.

Exhibits II and III, which are attached to the Declaration, show the important effects resulting from an elevated Si content. Exhibit II shows the effect of Si in retarding softening

when the tempering temperature is at 260°C (500°F) (top graph) as compared to a much higher tempering temperature at 540°C (1000°F) (bottom graph). Exhibit III shows how an elevated Si content produces much better impact strength when steels are tempered at 260°C (500°F). An elevated Si content alters the formation of carbides during tempering at 260°C (500°F). Steels with the more common low Si contents become embrittled when tempered at 260°C (500°F), while steels having more Si have a high impact strength when tempered at 260°C (500°F).

The heat treatment used to make the steel of the Subject Application produces unique mechanical properties which are significantly different from the properties that would be obtained as a result of the manufacturing temperatures taught in the cited references. The Declaration states, and the specification teaches, that the claimed alloy is tempered at a low temperature of about 260°C (500°F) to produce a very high ultimate tensile strength level, typically about 1,725 MPa (ultimate tensile strength ranging from about 233 to 270 ksi and typically, about 247 ksi, as shown in Table 3 of the Subject Application). The alloy of the Subject Application, produced as described therein, has a Charpy V-notch impact strength ranging from about 20 to 43 ft-lb. at -40°F, also shown in Table 3 of the Subject Application. The low tempering temperature used to make the claimed alloy also imparts a high degree of strain hardening (a low yield strength/tensile strength ratio), which allows products made with the claimed alloy to absorb high strain without fracturing.

The steels described in the cited references are all tempered at significantly higher temperatures to produce lower strength levels. Even if the foregoing substituents were to be used in the amounts described in the ranges described, the final product produced would have different properties from those of the claimed alloy because of the difference in the tempering temperature used. Exhibit I to the Declaration shows the tempering temperature that was used in the cited references where the temperature was disclosed at all. Mr. Paules also calculated for all but the Lee reference, the ultimate tensile strength of the alloys of each reference, based on the information provided therein. The alloy of the Subject Application has an ultimate tensile strength of about 1725 MPa, whereas the ultimate tensile strength of the alloys described in the Hasegawa, Ishii, Kenichi and Kishida references are lower, and in most cases, significantly lower.

None of the cited references describe the combination of low levels of carbon, high levels of silicon, high levels tungsten and elevated levels of nickel to produce a low alloy steel having the strength and/or toughness properties of the claimed alloy.

Referring again to Exhibit I of the Declaration, the cited references disclose properties such as high temperature creep strength, weldability, and isotropic toughness developed for applications such as boiler tubes, steam valves, and hot working dies. The steel alloy of the Subject Application, on the other hand, was specifically designed to achieve maximum tensile strength, strain hardening, and impact toughness under dynamic loading conditions at ambient temperatures, properties which allow products made with the alloy, such as penetrator bombs, to survive target penetration.

As described in the Subject Application at page 2, lines 1-4 and page 3, paragraph 0007, the claimed steel alloy is particularly useful for penetrator bombs intended for deep penetration beneath the earth and the sublevels of buildings. Steel that can become brittle would be useless for this and other high impact commercial applications. Thus, the unique combination of elements in the amounts claimed when processed in the manner described in the Subject Application provides a steel alloy having unique properties suited for high strength, high impact uses.

In the Hasagawa patent, tempering temperatures of 780°C and 750°C are described in col.7, lines 13 and 65, respectively. In the Declaration, Mr. Paules has converted the lowest temperature to 1380°F. At tempering temperatures that high, the tensile strength of the resulting alloy would be lower than that of the claimed alloy. In the Ishii patent, in col. 8, lines 38-45, the tempering temperature is described as between 680°C and 740°C (1256-1364°F, with the assumption that 7400°C in line 42 is a typographical error in view of the use of 740°C in the same paragraph). In the next paragraph, the tempering temperature is described at 720-780°C (1328-1436°F). Ishii states at col. 11, lines 14-16 that the tensile strength is between 720-770 MPa and shows examples within and around that range in Table 2.

The Lee Abstract states that the tempering temperature is 640-660°C (1164-1220°F). Although Si is listed as being as high as 1.0% of the steel slab, the fact that the alloy is heated at

such high temperatures means that the tensile strength should be low relative to that of applicants' claimed alloy. The Kenichi patent describes a tempering temperature of 650°C (1202°F) at pages 4 and 10 of the English language translation of the Japanese publication. Like Lee, the tensile strength should be low relative to that of applicants' claimed alloy.

The Kishida patent describes a high carbon, high chromium, high molybdenum tool steel. One skilled in the art would infer that the tempering temperature must be high because the steel is used for a hot working tool steel. When the final product is in contact with heat during use, it has to survive exposure to high temperatures. Such steels must be tempered at temperatures higher than those that the product will be exposed to in use, typically at about 1000°F or higher. In Examples 2 and 3, the steel has a HRC hardness of 45, (which can be converted to 1480 MPa as shown in Exhibit I of the Declaration), which is significantly lower than the tensile strength of applicant's claimed alloy.

Referring to the bases for rejection set forth under numbers 1 – 11 above, applicants submit that none of the cited references, alone or in combination, teach or suggest, the alloy recited in claims 1, 2, 23, 24, 27-35 or the bomb casing material recited in claims 21, 22, 25 or 26. The cited references reveal no evidence of recognition of, or any attempt to address, the problems the claimed alloy was developed to solve. Based on the information provided by Mr. Paules, none of the cited references teach or suggest, alone or in combination, an alloy that *could* solve the problems the claimed alloy was developed to solve.

Withdrawal of the following rejections is requested:

claim 1 under 35 U.S.C. §102 (a) in view of Hasegawa or Ishii;

claim 2 under 35 U.S.C. §103(a) over Hasegawa in view of Table 1.1 of Introduction to Steels and Cast Irons;

claim 21 under 35 U.S.C. §102 (a) or 35 U.S.C. §103(a) over the Ishii alone or in view of Lyon;

claims 21 and 22 under 35 U.S.C. §103(a) over the Hasegawa patent alone or in view of Lyon;.

claim 1 under 35 U.S.C. §103(a) over Lee;

claims 1 and 2 under 35 U.S.C. §103(a) over Kenichi;

claims 1 and 2 under 35 U.S.C. §103(a) over Kenichi in view of Table 1.1 of Introduction to Steels and Cast Irons;

claims 21 and 22 under 35 U.S.C. §103(a) over the combination of Kenichi and Lyon;

claim 23 under 35 U.S.C. §103(a) over Lee in view of Table 1.1 of Introduction to Steels and Cast Irons;

claims 23 and 24 under 35 U.S.C. §103(a) over Kenichi in view of Table 1.1 of Introduction to Steels and Cast Irons; and

claims 1, 23 and 24 under 35 U.S.C. §103(a) over Kishida.

Claims 1, 2 and 21-35 recite a novel and nonobvious steel alloy. Entry of the amendments, consideration of the claims, evidence and information provided herein and allowance of claims 1, 2 and 21-35 are respectfully requested.

Conclusion

Applicants have made every effort to advance prosecution of the Subject Application. Claims 1, 2, 23 and 24 have been amended and new claims 25 to 35 have been added. The claims are believed to be in condition for allowance. Reconsideration and allowance of claims 1, 2, 21 to 24 and consideration and allowance of new claims 25 to 35 are respectfully requested. If the undersigned can be of any assistance to the Examiner in advancing the application to allowance, the Examiner is urged to contact the undersigned attorney at the number set forth below.

Respectfully submitted,

Christine R. Ethridge
Christine R. Ethridge
Registration No. 30,557
Attorney for Applicant

Kirkpatrick & Lockhart Nicholson Graham LLP
Henry W. Oliver Building
535 Smithfield Street
Pittsburgh, Pennsylvania 15222-2312

(412) 355-8619 (Voice)
(412) 355-6501 (FAX)